Data Project No 3 - Avellaneda-Lee Statistical Arbitrage Model:

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1. **The stock portfolio we are be testing against is Boeing, denote the price at t_n by S_n, and let n be the price of the ETF SPY at t_n. We will use the first half to estimate the model parameters α, β, ϕ, m, and σ.**

```
SPY mu      Boeing mu
0.2494221442 0.2926018355

SPY vol        Boeing vol
0.09683173942 0.2437003078

beta 1.607652941
alpha -0.0004300889219

b 0.9106580746
a -0.0009714459922
dt 0.003968253968
kappa 23.58412104
m -0.01087334964
sigma 0.1919032808
```

2. **The following dimensional variable is introduced to be viewed as a score that indicates the relative $S - I$ prices being high or low:**

$$s = \frac{(X(t) - m)\sqrt{-\frac{2\ log\ \phi}{\Delta t}}}{\sigma} \tag{1}$$

By Equation (1), we see that s, representing the signal, indicates whether the relative price of our stock is high or low in comparison to the index of the market. $X(t)$ is an autoregressive model and denote m to be the mean. Therefore, the signal measures the departure of X(t) from the mean. We weight this value by an approximation of the normal fluctuation. Trading opportunities are suggested by s being either too small or too large.

Using the following trading rules, we will test the previous strategy:

$$\text{buy } S, \text{ sell } I \text{ if } s < -1.25$$
$$\text{buy } S, \text{ sell } I \text{ if } s > +1.25$$

Within the testing set, when s was bounded between -1.25 and $+$ 1.25, values within those bounds concluded that there was very little deviation relative to Boeing and SPY.

In the case where $s > +1.25$, this indicates that s is about to crash and since I is stable, we short Boeing and buy into SPY to restabilize.

When $s < -1.25$, the indication is that our stock has to go up to meet I (SPY) so we buy into S (Boeing).

A reasonable strategy would be for each dollar's worth of your portfolio you buy, you sell β dollar's worth of SPY.

For this project we will be referring to β as correlation, with the understanding that it is not exactly that.

By selling β's worth of stock when we do not have a beginning position means we are shorting said stock. By purchasing a dollars worth of a stock and shorting the other at β amount we are able to avoid risk by putting emphasis on the mean reversion for the deviance between the two, rather than putting emphasis on potential growth on one. This allows us to make positive returns despite whether the stock or the market is fluctuating as we are betting on the deviation alone. This allowed us to make a return of over 11.7 percent for the test case time frame relative to a return of less than 8.6 percent for the other two stocks alone during the same time period.

Graphs pertaining to $S - I$

SPY Close and Boeing Close
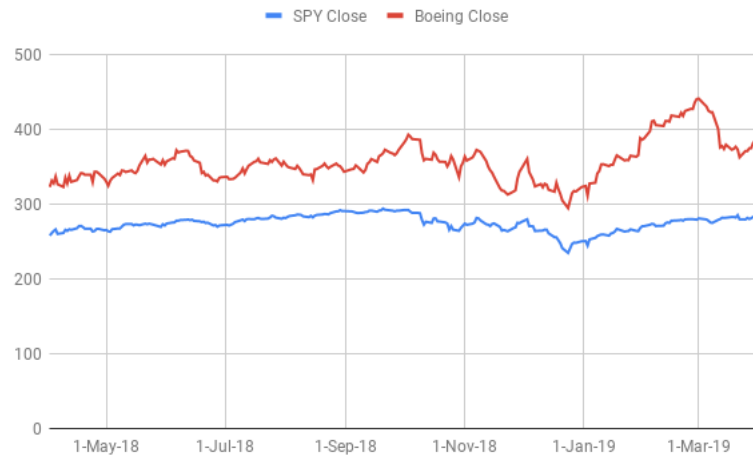
SPY Return and Boeing Return
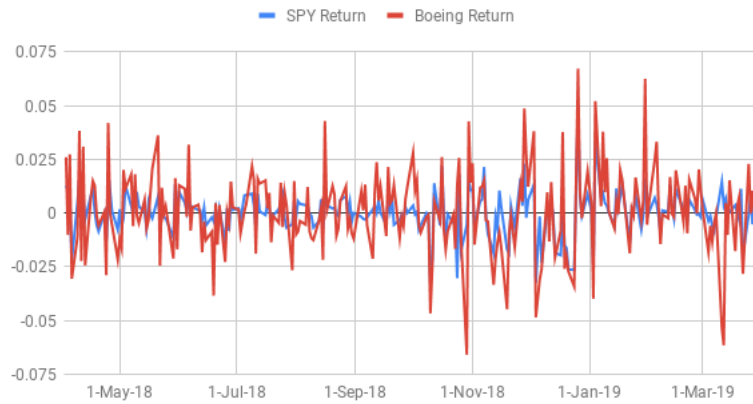
PNL Daily with Training and Test cases